

Claims

[c1] A tube fitting, comprising:

a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore that forms a camming surface; a drive member joinable with said body and having a ferrule drive surface; and a ferrule having a tapered nose portion that extends into said tapered mouth of the fitting body, a substantially continuous cylindrical interior wall that closely surrounds the tube end, and a driven surface on a back end thereof that engages said ferrule drive surface; said ferrule being case hardened about its entire surface, said ferrule having a rear portion of said cylindrical interior wall that is radially spaced from the tube end upon pull-up of the fitting, a forward edge of said tapered nose portion that penetrates an outer surface of the tube end, and a collet portion of said substantially continuous cylindrical interior wall that is axially behind said forward edge and that upon pull-up of the fitting is deformed radially against said outer surface of the tube end to collet the tube end.

[c2] The fitting of claim 1 wherein said ferrule is deformed

during pull-up of the fitting by a toggle-like hinging action.

- [c3] The fitting of claim 2 wherein said toggle-like hinging action results from said rear portion moving radially outward from said outer surface of the tube end about a region of said ferrule that joins said rear portion to said collet portion.
- [c4] The fitting of claim 3 wherein said toggle-like hinging action causes said collet portion to be radially compressed against said outer surface of the tube end with a high gripping pressure upon pull-up of the fitting.
- [c5] The fitting of claim 3 wherein said drive member ferrule drive surface initially contacts said ferrule driven surface at a location radially outward to at least a central portion of said ferrule driven surface.
- [c6] The fitting of claim 1 wherein said driven surface is convex.
- [c7] The fitting of claim 1 wherein said convex surface is curved.
- [c8] The fitting of claim 1 wherein said ferrule comprises metal.
- [c9] The fitting of claim 8 wherein said metal comprises

stainless steel.

- [c10] A tube fitting, comprising:
 - a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore that forms a camming surface; a drive member joinable with said body and having a ferrule drive surface; a ferrule having a substantially continuous cylindrical interior wall that closely surrounds the tube end, a tapered nose portion that extends into said tapered mouth, and a driven surface on a back end thereof that engages said ferrule drive surface; said ferrule having a rear portion of said cylindrical interior wall that is radially spaced from the tube end upon pull-up of the fitting, a forward edge of said tapered nose portion that penetrates an outer surface of the tube end, and a collet portion of said substantially continuous cylindrical interior wall that is axially behind said forward edge and that upon pull-up of the fitting is deformed by a toggle-like hinging action that results from said rear portion moving radially outward from said outer surface of the tube end about a region of said ferrule that joins said rear portion to said collet portion.
- [c11] The tube fitting of claim 10 wherein said collet portion is radially compressed against said outer surface of the tube end to collet the tube end with a high radial grip-

ping pressure.

- [c12] The tube fitting of claim 10 wherein said ferrule is case hardened about its entire surface.
- [c13] The fitting of claim 10 wherein said drive member ferrule drive surface initially contacts said ferrule driven surface at a location radially outward to at least a central portion of said ferrule driven surface.
- [c14] The fitting of claim 10 wherein said ferrule comprises metal.
- [c15] The fitting of claim 10 wherein said metal comprises stainless steel.
- [c16] A tube fitting, comprising:
 - a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore that forms a camming surface; a drive member having a threaded engagement with said body and having a ferrule drive surface; a ferrule having substantially continuous cylindrical interior wall that closely surrounds the tube end, a tapered nose portion that extends into said tapered mouth, and a driven surface on a back end thereof that engages said ferrule drive surface; said ferrule driven surface having a generally convex contour, a forward edge of said tapered nose portion that pene-

trates an outer surface of the tube end, and a portion of said substantially continuous cylindrical interior wall that is radially compressed by a toggle-like hinging action to collet the tube end near said forward edge.

- [c17] The tube fitting of claim 16 wherein said ferrule is case hardened over its entire surface.
- [c18] The tube fitting of claim 16 wherein said ferrule has a rear portion of said cylindrical interior wall that is radially spaced from the tube end upon pull-up of the fitting.
- [c19] The fitting of claim 16 wherein said ferrule comprises metal.
- [c20] The fitting of claim 16 wherein said metal comprises stainless steel.
- [c21] A tube fitting, comprising:
 - a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore that forms a camming surface; a drive member joinable with said body and having a ferrule drive surface; a ferrule having a substantially continuous cylindrical interior wall that closely surrounds the tube end, a tapered nose portion that extends into said tapered mouth, and a driven surface on a back end thereof that

engages said ferrule drive surface; said ferrule driven surface having a generally convex contour, a forward edge of said tapered nose portion that penetrates an outer surface of the tube end, a portion of said substantially continuous cylindrical interior wall that is radially compressed to collet the tube end near said forward edge, and a rear portion of said cylindrical interior wall that is radially spaced from the tube end upon pull-up of the fitting.

- [c22] The tube fitting of claim 21 wherein said ferrule is case hardened over its entire surface.
- [c23] The fitting of claim 21 wherein said ferrule is deformed during pull-up of the fitting by a toggle-like hinging action.
- [c24] The fitting of claim 23 wherein said toggle-like hinging action results from said rear portion moving radially outward from said outer surface of the tube end about a region of said ferrule that joins said rear portion to said collet portion.
- [c25] The tube fitting of claim 24 wherein said ferrule is case hardened over its entire surface.
- [c26] The fitting of claim 21 wherein said drive member ferrule drive surface initially contacts said ferrule driven surface

at a location radially outward to at least a central portion of said ferrule driven surface.

- [c27] The fitting of claim 21 wherein said ferrule interior cylindrical wall comprises a circumferential recess between said forward edge and said back end.
- [c28] The fitting of claim 21 wherein said ferrule comprises metal.
- [c29] The fitting of claim 21 wherein said metal comprises stainless steel.
- [c30] A method for sealing and gripping a tube end with a tube fitting of the type having a fitting body and nut that are joinable and enclose a tube end, and a ferrule that has a forward portion that engages the body and a rearward portion that is driven by the nut when the fitting is pulled up, the method comprising the steps of:
 - deforming the ferrule during pull-up of the fitting so as to cause a back end thereof to be radially spaced from the tube end upon pull-up;
 - deforming the ferrule during pull-up so as to cause a front edge thereof to indent into the tube end; and
 - deforming the ferrule during pull-up with a toggle-like hinging action so that a collet portion thereof is radially compressed against the tube end.

- [c31] The method of claim 30 wherein said collet portion is axially behind said indented front edge to isolate said indented front edge from vibration.
- [c32] The method of claim 30 comprising the step of case hardening the ferrule over its entire surface prior to assembly into the fitting.
- [c33] The method of claim 30 comprising the step of forming a circumferential recess in a central bore of the ferrule prior to assembly into the fitting.
- [c34] The method of claim 30 comprising the step of forming a convex driven surface at said back end of the ferrule prior to assembly into the fitting.
- [c35] A tube fitting comprising:
 - a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore;
 - a drive member having a threaded engagement with said body and having a ferrule drive surface;
 - a ferrule having a substantially continuous cylindrical interior wall that closely surrounds the tube end when installed thereon, a tapered nose portion that can be inserted into said tapered mouth, and a driven surface on a back end thereof that engages said ferrule drive sur-

face during pull-up of the fitting; and
wherein said ferrule is case hardened about its entire
surface, and said ferrule has a configuration such that
upon pull-up of the fitting said ferrule will deform to
cause: 1) a rear portion of said cylindrical interior wall to
be radially spaced from the tube end, 2) a forward edge
of said tapered nose portion to penetrate an outer sur-
face of the tube end, and 3) a collet portion of said sub-
stantially continuous cylindrical interior wall that is axi-
ally behind said forward edge to be deformed radially
against said outer surface of the tube end to collet the
tube end.

[c36] A tube fitting comprising:

- a fitting body having a cylindrical bore for receiving a tube end and including a tapered mouth at one end of said bore;
- a drive member having a threaded engagement with said body and having a ferrule drive surface;
- a ferrule having a substantially continuous cylindrical in-
terior wall that closely surrounds the tube end when in-
stalled thereon, a tapered nose portion that can be in-
serted into said tapered mouth, and a driven surface on
a back end thereof that engages said ferrule drive sur-
face during pull-up of the fitting; and
- wherein said ferrule is case hardened about its entire

surface, and said ferrule has a configuration such that upon pull-up of the fitting said ferrule will deform with a toggle-like hinging action.

[c37] The tube fitting of claim 36 wherein during said toggle-like hinging action said ferrule will plastically deform so that: 1) a rear portion of said cylindrical interior wall will be radially spaced from the tube end, 2) a forward edge of said tapered nose portion will penetrate an outer surface of the tube end, and 3) a collet portion of said substantially continuous cylindrical interior wall that is axially behind said forward edge will be deformed radially against said outer surface of the tube end to collet the tube end